IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application of

Applicants : John T. Davlin et al.
Serial No. : 09/651,498
Filed : August 30, 2000
Title : TEMPERATURE CONTROL ELEMENTS, SPINDLE ASSEMBLY AND WAFER PROCESSING ASSEMBLY INCORPORATING SAME
Docket : MIO 0071 PA (00-0430)
Examiner : R. Kackar
Art Unit : 1763

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Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

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John D. Reed Reg. No. 46,506

Sir:

APPEAL BRIEF

This is an appeal from the Office Action mailed May 5, 2004, finally rejecting claims 36, 39-42 and 44-46. A Notice of Appeal was timely filed on June 11, 2004. A Credit Card Payment Form (PTO-2038) in the amount of $330.00 accompanies this Brief. 37 CFR §1.17(c).

(1) Real Party In Interest

The real party in interest is the Assignee of this patent application, Micron Technology, Inc., a corporation of the State of Idaho, by assignment from the named inventors, which assignment has been recorded at the United States Patent & Trademark Office on December 4, 2000, Reel 011345, Frame 0799.

(2) Related Appeals and Interferences

The Appellants have filed a Notice of Appeal dated August 9, 2004 on a related divisional application (serial number 10/320,073, filed December 16, 2002), also before the same Examiner.

(3) Status of Claims

Claims 36, 39-42 and 44 through 46 are present in this patent application, and all stand finally rejected. Claims 1 through 35, 37, 38 and 43 have been cancelled. Accordingly, claims 36, 39 through 42 and 44 through 46 are before this Board on appeal. A correct copy of the appealed claims appears as an Appendix to this Brief.

(4) Status of Amendments

All previous amendments have been entered. The Appellants have not filed any response or amendment subsequent to the Final Office Action.

(5) Summary of the Invention:

The Appellants' invention relates to a rotary spindle assembly for production of wafers (such as semiconductor wafers) wherein a wafer is coated or otherwise processed while supported on a rotatable wafer support. Specialized temperature control and spindle rotation features, as well as wafer processing equipment are provided to improve wafer processing uniformity and accuracy. The temperature control features, including a heat regulating element **50** and a heat regulating flange **30**, are arranged as part of the assembly. The heat regulating element is made up of a fluid conduit **58** that defines a substantially cylindrical heat regulation void about at least a portion of a rotary spindle **24**. In addition, the heat regulating element **50** and the attendant gas path defined therethrough is of an open framework construction such that a substantial degradation of the gas flow profile is avoided. During assembly operation, the configuration is such that a thermal control fluid (for example, water) passes through the fluid conduit **58** and exchanges heat with the gas that is being circulated through the heat regulation void and past a support **70** of a wafer **75** being processed. As shown in FIGS. 2 and 4 of the original specification, the flowpath traversed by fluid conduit **58** can be of a helical shape and sized by diameter **a** relative to the diameter **b** of spindle **24** such that the heat regulation void takes up the space between them. The heat regulating flange **30** (shown in original FIGS. 1 through 3) is disposed between the heat regulating element **50** and a controller **60**,

and serves to thermally decouple the wafer and its support from the rotary spindle, motor and related componentry.

(6) Issues

(a) Whether claim 36 is nonobvious under 35 USC §103(a) over U.S. Patent 5,762,709 to Sugimoto et al (hereinafter the '709 patent) in view of U.S. Patent 5,578,127 to Kimura (hereinafter the '127 patent).

(b) Whether claims 44 through 46 are nonobvious under 35 USC §103(a) over the '709 patent in view of the '127 patent.

(c) Whether claims 39 through 42 are nonobvious under 35 USC §103(a) over the '709 patent in view of the '127 patent and further in view of U.S. Patent 6,107,608 to Hayes (hereinafter the '608 patent).

(7) Grouping of Claims

The Applicant will argue each ground of rejection using representative claims. Claim 36 is representative of claim 36 in regard to the §103 rejection of unpatentability over the '709 patent in view of the '127 patent. Claim 44 is representative of claims 44 through 46 in regard to the §103 rejection of unpatentability over the '709 patent in view of the '127 patent. Claim 39 is representative of claims 39 through 42 in regard to the §103 rejection of unpatentability over the '709 patent in view of the '127 patent and further in view of the '608 patent. As such, the representative claims do not stand or fall together.

(8) Argument

(a) Claim 36, which recites an open framework heat regulating structure defining a heat exchange relationship between fluid in a fluid conduit and a gas passing through a substantially cylindrical heat regulating void that is at least partially formed by the fluid conduit, is nonobvious under 35 USC 103(a) over the '709 patent in view of the '127 patent.

The Examiner asserts that the combination of the '709 and '127 patents show a wafer coating apparatus with the claimed heat regulating element; however, recourse to these references is unavailing, as there in neither a teaching nor a suggestion of the claimed open framework heat regulating element. Accordingly, the Examiner's position is deficient as a matter of law, as it fails to satisfy all of the requirements of a proper obviousness rejection. "To establish a *prima facie* case of obviousness, three basic criteria must be met." MPEP 2142. Among these is the bedrock principle that all claim limitations should be taught or suggested. MPEP 2143.03. In the present case, there are at least two examples of the Examiner ignoring this stricture. First, the airflow mechanism of the '709 patent used in a heat regulating capacity teaches a closed configuration, as evidenced by the air supply conduit **30** and damper **40** shown in FIG. 2 in conjunction with frequent description of the small nature of the conduit openings discussed at column 5, lines 39 through 43. The Appellants position has been all along that the preservation of gaseous flow characteristics through an open framework enhances the performance of the assembly. The entrained, damper-based approach adopted by the '709 patent is not only not taught or suggested, but represents a complete dissimilarity in the way thermal management issues are addressed. This distinction is not remedied by the '127 patent, where its complete absence of any type of framework, whether open or closed, about a spindle such that a heat regulation void is defined between the spindle and element prevents the Examiner's use of the '127 patent as a secondary teaching. The Examiner's position, that the fluid temperature control of the flange of the '127 patent teaches a heat exchange device similar to that of

the claimed device, is misplaced, as it seeks to mimic the open framework heat regulation void defined between the spindle and fluid conduit where no such structure exists.

Second, while the combination of the '709 and '127 patents does teach a wafer coating device with an adjustable airflow mechanism to circulate air around a rotary spindle, it is silent as to using a heat exchange arrangement between the flowing air and a heat regulating fluid disposed in conduit around that spindle. Furthermore, neither of the teachings of the '709 or '127 patents, taken alone or together, even remotely suggest the possibility of having the aforementioned heat exchange relationship between the two fluids, nor could they expect to, as the '709 patent is silent as to using a heat exchange fluid, and the '127 patent limits the use of such fluid to the heat regulating flange, avoiding any discussion as to any applicability of a heat exchange relationship between the exhaust gas and a cooling fluid in the vicinity of the spindle. The Examiner candidly admits in numbered paragraph 2 of the May 5, 2004 Office Action that the '709 patent does not teach the construction of the claimed heat regulating element, and attempts to rectify this deficiency by recourse to the '127 patent. Whatever features the '127 patent discusses, a heat-exchange fluid conduit disposed about the rotary spindle is not one of them. As an attempt to gloss over this shortcoming of the secondary reference, the Examiner asserts at the bottom of page 4 of the February 10, 2004 Office Action that heat exchange occurs with fluid in a conduit "all around", leaving the meaning of such phrase open to speculation. There is no evidence that the '127 patent teaches or suggests that a fluid conduit be placed about the spindle **31a** to effect a heat exchange relationship with exhaust gas flowing past the spindle. In fact, the only discussion in the '127 patent of conduit used to transport heat exchange fluid is made in conjunction with the aforementioned flange **31b** (described at column 5, lines 17 through 29) and plate **20** (described at column 4, lines 47 through 51), as well as the resist supply nozzle **30** (described at column 5, lines 30 through 41). None of the heat exchange configurations depicted in the '127 patent contemplate a fluid conduit in heat exchange relationship with an exhaust gas in the region about the spindle for the purpose of cooling the exhaust gas. As such, the device of the '127 patent does not augment the teaching of the admittedly deficient '709 patent.

In addition to not teaching or suggesting every element of the claimed invention, the combination of the '709 and '127 patents is found wanting for other reasons. In particular, another portion of the tripartite test for a *prima facie* case of obviousness requires that there must be some motivation to combine the references. MPEP 2143.01. The antithesis of such motivation occurs when the reference(s) teach away from each other or the claimed invention; such a teaching away is a *per se* demonstration of lack of *prima facie* obviousness. See, e.g., *In re Dow Chemical Co.*, 837 F.2d 469, 5 USPQ2d 1529 (Fed. Cir. 1988). In the present case, the relatively closed configuration of the '709 patent not only does not avoid disruption of the exhaust gas flow within the assembly, but actually promotes it by increasing, decreasing or cutting off the air supply as needed. Using FIG. 2 relied on by the Examiner, it can be seen that the '709 patent teaches a substantially closed air supply conduit **30** arranged about the spindle **1a**. The air supply conduit **30** of the '709 patent is expressly presented to control the supply of air through the conduit to the lower surface of the substrate by using an air flow adjusting unit **50** coupled with a damper **40**. It will be appreciated by those skilled in the art that such a damper-based arrangement by its very nature defines a closed framework, and as such alters the exhaust gas profile defined by the wafer processing bowl. This stands in stark contrast to the open framework architecture of the claimed device, where (as stated at pages 3 and 11 of the original specification) the dimensions of the gas flow path avoid substantial degradation of a wafer processing assembly gas flow profile.

For this additional reason, continued reliance on the '709 patent as a primary reference is misplaced, as MPEP 2141.02 clearly recognizes that the "reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention." Thus, even assuming *arguendo* that there are features common to both the '709 patent and the claimed device, the presence of the closed air conduit and accompanying damper of the former provides indicia that the totality of the two devices are significantly different. With regard to independent claim 36, both the relatively closed framework of the '709 patent and the flow-disrupting damper mechanism are inconsistent with the stated purpose discussed above for the claimed device. Thus, Examiner's use of

the '709 patent presents a classic example of teaching away that is insufficient to render the claims at issue obvious.

(b) Claims 44 through 46, which recite structure defining a heat exchange relationship between fluid in a fluid conduit and a gas passing through a substantially cylindrical heat regulating void that is at least partially formed by the fluid conduit, are nonobvious under 35 USC 103(a) over the '709 patent in view of the '127 patent.

The Appellants' position regarding the inapplicability of the '709 and '127 patents, both individually and collectively, to the fluid conduit configuration of the heat regulating element of claim 36 discussed above is also relevant to claims 44 through 46, and for that reason alone is sufficient to overcome the Examiner's rejection. In addition, particular recitations within claim 44 that are not shared with claim 36 make the former separately patentable. For example, the heat regulating element of claim 44 additionally recites a frame to which the fluid conduit is coupled. The Examiner was keenly aware of this feature and its absence from the '709 patent, stating on page 2 of the May 5, 2004 Office Action that the '709 patent does "not disclose the regulating frame with fluid inlet and outlet". Yet, despite this clear admission, the Examiner then proceeds to ignore the frame limitation in the remainder of the rejection, as nowhere else is mention made of this shortcoming in the '709 patent or how the '127 patent corrects such shortcoming. "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)). Based on the combined failure of the Examiner to address this limitation and the lack of such limitation in the teaching of the '127 patent, the Appellants submit that these words were not considered in judging claim patentability. In light of this, for the Examiner to baldly hold that either of the '709 or '127 patents include such a frame as part of the heat regulating element would be to destroy the plain meaning of that claim requirement, and as such is contrary to present United States Patent and Trademark Office practice.

In addition, claim 44 specifically recites the heat regulating flange being disposed between the rotary drive motor and the wafer support, with the heat regulating element (frame included) positioned between the flange and wafer support. While the '127 patent includes a flange **31a** disposed between the rotary drive motor **31** and the wafer support **28** (as shown in FIG. 2), there is no evidence of a frame-based heat regulating element positioned between them and about the spindle such that a fluid can be routed through conduit that is coupled to the frame. Thus, as neither the '709 nor '127 patents teach or even remotely suggest the claimed arrangement of the heat regulating flange relative to the heat regulating element, as well as their relationship to the claimed rotary spindle assembly, the present rejection is defective, and must be withdrawn.

(c) Claims 39 through 42 that recite structure defining a heat exchange relationship between fluid in a fluid conduit and a gas passing through a substantially cylindrical heat regulating void that is at least partially formed by the fluid conduit, and that include a temperature-responsive heat regulating flange are nonobvious under 35 USC 103(a) over the '709 patent in view of the '127 patent and further in view of the '608 patent.

In the final rejection, the Examiner rejected claims 39 through 42 under 35 USC §103 as unpatentable over the '709 patent in view of the '127 patent and further in view of the '608 patent. The Appellants' position regarding the inapplicability of the '709 and '127 patents, both individually and collectively, to claims 36 and 44 through 46 discussed above is also relevant to claims 39 through 42, and for that reason alone is sufficient to overcome the Examiner's rejection. Moreover, the additional recitation of particular features relating to the heat regulating flange provides additional bases for distinguishing over the cited references. In the claimed device, the flange is one of a plurality of heat control devices in the assembly to provide thermal control of the gaseous environmental within the assembly, while the temperature-sensor embedded chuck of the '608 patent acts as a direct conductive temperature control of the wafer being processed. Claim 39 recites that

the heat regulating flange of claim 36 further comprises a temperature sensor positioned within the flange body. By contrast, the device taught in the '608 patent is a wafer chuck **20** upon which is placed the wafer **17** to be processed such that "active controlling of the temperature of the support surface" is achieved, as discussed at column 3, lines 12 through 13. Moreover, column 6, lines 14 through 19 state that "the chuck **20** is preferably maintained near or at the desired temperature for the wafer", and that the placement of the chuck **20** and wafer **17** is to ensure thermal equilibrium between the two. Thus, while the chuck may have a temperature sensor positioned within it, it is clear that the chuck is not the same as the claimed heat regulating flange, as the chuck **20** of the '608 patent is a conductive heat transfer device operating specifically on and in contact with the wafer **17**, while the flange of the claimed device insulates the gaseous environment within the assembly from the heat generated by the motor used to rotate the spindle. Furthermore, the difference in placement of the claimed flange versus the chuck **20** of the '608 patent belies any similarity in function, as the flange is disposed at the "lower spindle area" according to claim 36 while the chuck **20** of the '608 patent must, out of necessity, be in physical contact with the wafer **17**. This dissimilarity is further evidenced by the position taken by the patentee in the '608 patent, where at column 8, lines 46 through 51, the active control of chuck **20** is used to directly control the temperature of wafer **17** thereby reducing or eliminating the need for the environmental control system of the claimed invention.

Conclusion

For all of these reasons, Appellants submit that the rejections are not well taken, and all rejections of the claims should be reversed in their entirety by this Board.

Respectfully submitted,
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APPENDIX

CLAIMS ON APPEAL

1-35 (Cancelled)

36. A rotary spindle assembly comprising a rotary drive motor, a rotary spindle, a wafer support, a wafer processing bowl, a heat regulating flange, and a heat regulating element, wherein:

said wafer support is secured to said rotary spindle so as to be rotatable with said spindle;

said rotary spindle defines a lower spindle area and an upper spindle area;

said rotary spindle is mechanically coupled to said rotary drive motor in said lower spindle area;

said heat regulating flange is positioned in said lower spindle area;

said heat regulating element is positioned in said upper spindle area between said heat regulating flange and said wafer support such that a fluid conduit disposed in said heat regulating element and configured to transport a thermal control fluid therethrough defines a substantially cylindrical heat regulation void about a portion of said rotary spindle in said upper spindle area, said heat regulation void thermally coupled to said fluid conduit such that upon passage of a fluid through said fluid conduit and exhaust gases through said heat regulation void, an exchange of heat occurs therebetween; and

said heat regulating element defines an open framework arranged about said rotary spindle such that upper and lower ends of said heat regulating element are open to said substantially cylindrical heat regulation void from said lower spindle area to said upper spindle area.

37. (Cancelled)

38. (Cancelled)

39. A rotary spindle assembly as claimed in claim 36 wherein said heat regulating flange further comprises a temperature sensor positioned within said flange body proximate said rotary spindle passage.

40. A rotary spindle assembly as claimed in claim 39 wherein said rotary spindle assembly further comprises:

at least one liquid source coupled to said fluid conduit; and

a controller coupled to said at least one liquid source and said temperature sensor, said controller being programmed to be responsive to a temperature signal generated by said temperature sensor.

41. A rotary spindle assembly as claimed in claim 39 wherein said temperature sensor is positioned within a bore defined within said flange body;

42. A rotary spindle assembly as claimed in claim 41 wherein said bore extends from an outer periphery of said flange body to an inner periphery of said flange body proximate a rotary spindle passage defined in said flange body.

43. (Cancelled)

44. A rotary spindle assembly comprising:

a rotary drive motor;

a rotary spindle rotatably responsive to said rotary drive motor;

a wafer support secured to said rotary spindle so as to be rotatable therewith;

a heat regulating flange positioned between said rotary drive motor and said wafer support; and

a heat regulating element positioned between said heat regulating flange and said wafer

support, said heat regulating element comprising:

a frame disposed about said rotary spindle; and

a fluid conduit coupled to said frame such that a heat regulation void is defined between said spindle and said fluid conduit, said heat regulation void thermally coupled to said fluid conduit such that upon passage of said fluid through said fluid conduit and upon passage of an exhaust gas through said heat regulation void, an exchange of heat occurs between said exhaust gas and said fluid.

45. A rotary spindle assembly as claimed in claim 44 wherein said fluid conduit is disposed within said frame to define a substantially cylindrical shape to said heat regulation void.

46. A rotary spindle assembly as claimed in claim 45 wherein said fluid conduit is disposed within said frame in a substantially circumferential path.

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and serves to thermally decouple the wafer and its support from the rotary spindle, motor and related componentry.

(6) Issues

(a) Whether claim 36 is nonobvious under 35 USC §103(a) over U.S. Patent 5,762,709 to Sugimoto et al (hereinafter the '709 patent) in view of U.S. Patent 5,578,127 to Kimura (hereinafter the '127 patent).

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(7) Grouping of Claims

The Applicant will argue each ground of rejection using representative claims. Claim 36 is representative of claim 36 in regard to the §103 rejection of unpatentability over the '709 patent in view of the '127 patent. Claim 44 is representative of claims 44 through 46 in regard to the §103 rejection of unpatentability over the '709 patent in view of the '127 patent. Claim 39 is representative of claims 39 through 42 in regard to the §103 rejection of unpatentability over the '709 patent in view of the '127 patent and further in view of the '608 patent. As such, the representative claims do not stand or fall together.

(8) Argument

(a) Claim 36, which recites an open framework heat regulating structure defining a heat exchange relationship between fluid in a fluid conduit and a gas passing through a substantially cylindrical heat regulating void that is at least partially formed by the fluid conduit, is nonobvious under 35 USC 103(a) over the '709 patent in view of the '127 patent.

The Examiner asserts that the combination of the '709 and '127 patents show a wafer coating apparatus with the claimed heat regulating element; however, recourse to these references is unavailing, as there in neither a teaching nor a suggestion of the claimed open framework heat regulating element. Accordingly, the Examiner's position is deficient as a matter of law, as it fails to satisfy all of the requirements of a proper obviousness rejection. "To establish a *prima facie* case of obviousness, three basic criteria must be met." MPEP 2142. Among these is the bedrock principle that all claim limitations should be taught or suggested. MPEP 2143.03. In the present case, there are at least two examples of the Examiner ignoring this stricture. First, the airflow mechanism of the '709 patent used in a heat regulating capacity teaches a closed configuration, as evidenced by the air supply conduit **30** and damper **40** shown in FIG. 2 in conjunction with frequent description of the small nature of the conduit openings discussed at column 5, lines 39 through 43. The Appellants position has been all along that the preservation of gaseous flow characteristics through an open framework enhances the performance of the assembly. The entrained, damper-based approach adopted by the '709 patent is not only not taught or suggested, but represents a complete dissimilarity in the way thermal management issues are addressed. This distinction is not remedied by the '127 patent, where its complete absence of any type of framework, whether open or closed, about a spindle such that a heat regulation void is defined between the spindle and element prevents the Examiner's use of the '127 patent as a secondary teaching. The Examiner's position, that the fluid temperature control of the flange of the '127 patent teaches a heat exchange device similar to that of

the claimed device, is misplaced, as it seeks to mimic the open framework heat regulation void defined between the spindle and fluid conduit where no such structure exists.

Second, while the combination of the '709 and '127 patents does teach a wafer coating device with an adjustable airflow mechanism to circulate air around a rotary spindle, it is silent as to using a heat exchange arrangement between the flowing air and a heat regulating fluid disposed in conduit around that spindle. Furthermore, neither of the teachings of the '709 or '127 patents, taken alone or together, even remotely suggest the possibility of having the aforementioned heat exchange relationship between the two fluids, nor could they expect to, as the '709 patent is silent as to using a heat exchange fluid, and the '127 patent limits the use of such fluid to the heat regulating flange, avoiding any discussion as to any applicability of a heat exchange relationship between the exhaust gas and a cooling fluid in the vicinity of the spindle. The Examiner candidly admits in numbered paragraph 2 of the May 5, 2004 Office Action that the '709 patent does not teach the construction of the claimed heat regulating element, and attempts to rectify this deficiency by recourse to the '127 patent. Whatever features the '127 patent discusses, a heat-exchange fluid conduit disposed about the rotary spindle is not one of them. As an attempt to gloss over this shortcoming of the secondary reference, the Examiner asserts at the bottom of page 4 of the February 10, 2004 Office Action that heat exchange occurs with fluid in a conduit "all around", leaving the meaning of such phrase open to speculation. There is no evidence that the '127 patent teaches or suggests that a fluid conduit be placed about the spindle **31a** to effect a heat exchange relationship with exhaust gas flowing past the spindle. In fact, the only discussion in the '127 patent of conduit used to transport heat exchange fluid is made in conjunction with the aforementioned flange **31b** (described at column 5, lines 17 through 29) and plate **20** (described at column 4, lines 47 through 51), as well as the resist supply nozzle **30** (described at column 5, lines 30 through 41). None of the heat exchange configurations depicted in the '127 patent contemplate a fluid conduit in heat exchange relationship with an exhaust gas in the region about the spindle for the purpose of cooling the exhaust gas. As such, the device of the '127 patent does not augment the teaching of the admittedly deficient '709 patent.

In addition to not teaching or suggesting every element of the claimed invention, the combination of the '709 and '127 patents is found wanting for other reasons. In particular, another portion of the tripartite test for a *prima facie* case of obviousness requires that there must be some motivation to combine the references. MPEP 2143.01. The antithesis of such motivation occurs when the reference(s) teach away from each other or the claimed invention; such a teaching away is a *per se* demonstration of lack of *prima facie* obviousness. See, e.g., *In re Dow Chemical Co.*, 837 F.2d 469, 5 USPQ2d 1529 (Fed. Cir. 1988). In the present case, the relatively closed configuration of the '709 patent not only does not avoid disruption of the exhaust gas flow within the assembly, but actually promotes it by increasing, decreasing or cutting off the air supply as needed. Using FIG. 2 relied on by the Examiner, it can be seen that the '709 patent teaches a substantially closed air supply conduit **30** arranged about the spindle **1a**. The air supply conduit **30** of the '709 patent is expressly presented to control the supply of air through the conduit to the lower surface of the substrate by using an air flow adjusting unit **50** coupled with a damper **40**. It will be appreciated by those skilled in the art that such a damper-based arrangement by its very nature defines a closed framework, and as such alters the exhaust gas profile defined by the wafer processing bowl. This stands in stark contrast to the open framework architecture of the claimed device, where (as stated at pages 3 and 11 of the original specification) the dimensions of the gas flow path avoid substantial degradation of a wafer processing assembly gas flow profile.

For this additional reason, continued reliance on the '709 patent as a primary reference is misplaced, as MPEP 2141.02 clearly recognizes that the "reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention." Thus, even assuming *arguendo* that there are features common to both the '709 patent and the claimed device, the presence of the closed air conduit and accompanying damper of the former provides indicia that the totality of the two devices are significantly different. With regard to independent claim 36, both the relatively closed framework of the '709 patent and the flow-disrupting damper mechanism are inconsistent with the stated purpose discussed above for the claimed device. Thus, Examiner's use of

the '709 patent presents a classic example of teaching away that is insufficient to render the claims at issue obvious.

(b) Claims 44 through 46, which recite structure defining a heat exchange relationship between fluid in a fluid conduit and a gas passing through a substantially cylindrical heat regulating void that is at least partially formed by the fluid conduit, are nbnobvious under 35 USC 103(a) over the '709 patent in view of the '127 patent.

The Appellants' position regarding the inapplicability of the '709 and '127 patents, both individually and collectively, to the fluid conduit configuration of the heat regulating element of claim 36 discussed above is also relevant to claims 44 through 46, and for that reason alone is sufficient to overcome the Examiner's rejection. In addition, particular recitations within claim 44 that are not shared with claim 36 make the former separately patentable. For example, the heat regulating element of claim 44 additionally recites a frame to which the fluid conduit is coupled. The Examiner was keenly aware of this feature and its absence from the '709 patent, stating on page 2 of the May 5, 2004 Office Action that the '709 patent does "not disclose the regulating frame with fluid inlet and outlet". Yet, despite this clear admission, the Examiner then proceeds to ignore the frame limitation in the remainder of the rejection, as nowhere else is mention made of this shortcoming in the '709 patent or how the '127 patent corrects such shortcoming. "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)). Based on the combined failure of the Examiner to address this limitation and the lack of such limitation in the teaching of the '127 patent, the Appellants submit that these words were not considered in judging claim patentability. In light of this, for the Examiner to baldly hold that either of the '709 or '127 patents include such a frame as part of the heat regulating element would be to destroy the plain meaning of that claim requirement, and as such is contrary to present United States Patent and Trademark Office practice.

In addition, claim 44 specifically recites the heat regulating flange being disposed between the rotary drive motor and the wafer support, with the heat regulating element (frame included) positioned between the flange and wafer support. While the '127 patent includes a flange **31a** disposed between the rotary drive motor **31** and the wafer support **28** (as shown in FIG. 2), there is no evidence of a frame-based heat regulating element positioned between them and about the spindle such that a fluid can be routed through conduit that is coupled to the frame. Thus, as neither the '709 nor '127 patents teach or even remotely suggest the claimed arrangement of the heat regulating flange relative to the heat regulating element, as well as their relationship to the claimed rotary spindle assembly, the present rejection is defective, and must be withdrawn.

(c) Claims 39 through 42 that recite structure defining a heat exchange relationship between fluid in a fluid conduit and a gas passing through a substantially cylindrical heat regulating void that is at least partially formed by the fluid conduit, and that include a temperature-responsive heat regulating flange are nonobvious under 35 USC 103(a) over the '709 patent in view of the '127 patent and further in view of the '608 patent.

In the final rejection, the Examiner rejected claims 39 through 42 under 35 USC §103 as unpatentable over the '709 patent in view of the '127 patent and further in view of the '608 patent. The Appellants' position regarding the inapplicability of the '709 and '127 patents, both individually and collectively, to claims 36 and 44 through 46 discussed above is also relevant to claims 39 through 42, and for that reason alone is sufficient to overcome the Examiner's rejection. Moreover, the additional recitation of particular features relating to the heat regulating flange provides additional bases for distinguishing over the cited references. In the claimed device, the flange is one of a plurality of heat control devices in the assembly to provide thermal control of the gaseous environmental within the assembly, while the temperature-sensor embedded chuck of the '608 patent acts as a direct conductive temperature control of the wafer being processed. Claim 39 recites that

the heat regulating flange of claim 36 further comprises a temperature sensor positioned within the flange body. By contrast, the device taught in the '608 patent is a wafer chuck **20** upon which is placed the wafer **17** to be processed such that "active controlling of the temperature of the support surface" is achieved, as discussed at column 3, lines 12 through 13. Moreover, column 6, lines 14 through 19 state that "the chuck **20** is preferably maintained near or at the desired temperature for the wafer", and that the placement of the chuck **20** and wafer **17** is to ensure thermal equilibrium between the two. Thus, while the chuck may have a temperature sensor positioned within it, it is clear that the chuck is not the same as the claimed heat regulating flange, as the chuck **20** of the '608 patent is a conductive heat transfer device operating specifically on and in contact with the wafer **17**, while the flange of the claimed device insulates the gaseous environment within the assembly from the heat generated by the motor used to rotate the spindle. Furthermore, the difference in placement of the claimed flange versus the chuck **20** of the '608 patent belies any similarity in function, as the flange is disposed at the "lower spindle area" according to claim 36 while the chuck **20** of the '608 patent must, out of necessity, be in physical contact with the wafer **17**. This dissimilarity is further evidenced by the position taken by the patentee in the '608 patent, where at column 8, lines 46 through 51, the active control of chuck **20** is used to directly control the temperature of wafer **17** thereby reducing or eliminating the need for the environmental control system of the claimed invention.

Serial No. 09/651,498
Docket MIO 0071 PA/(00-0430)

Conclusion

For all of these reasons, Appellants submit that the rejections are not well taken, and all rejections of the claims should be reversed in their entirety by this Board.

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APPENDIX

CLAIMS ON APPEAL

1-35 (Cancelled)

36. A rotary spindle assembly comprising a rotary drive motor, a rotary spindle, a wafer support, a wafer processing bowl, a heat regulating flange, and a heat regulating element, wherein:

said wafer support is secured to said rotary spindle so as to be rotatable with said spindle;

said rotary spindle defines a lower spindle area and an upper spindle area;

said rotary spindle is mechanically coupled to said rotary drive motor in said lower spindle area;

said heat regulating flange is positioned in said lower spindle area;

said heat regulating element is positioned in said upper spindle area between said heat regulating flange and said wafer support such that a fluid conduit disposed in said heat regulating element and configured to transport a thermal control fluid therethrough defines a substantially cylindrical heat regulation void about a portion of said rotary spindle in said upper spindle area, said heat regulation void thermally coupled to said fluid conduit such that upon passage of a fluid through said fluid conduit and exhaust gases through said heat regulation void, an exchange of heat occurs therebetween; and

said heat regulating element defines an open framework arranged about said rotary spindle such that upper and lower ends of said heat regulating element are open to said substantially cylindrical heat regulation void from said lower spindle area to said upper spindle area.

37. (Cancelled)

38. (Cancelled)

39. A rotary spindle assembly as claimed in claim 36 wherein said heat regulating flange further comprises a temperature sensor positioned within said flange body proximate said rotary spindle passage.

40. A rotary spindle assembly as claimed in claim 39 wherein said rotary spindle assembly further comprises:

at least one liquid source coupled to said fluid conduit; and

a controller coupled to said at least one liquid source and said temperature sensor, said controller being programmed to be responsive to a temperature signal generated by said temperature sensor.

41. A rotary spindle assembly as claimed in claim 39 wherein said temperature sensor is positioned within a bore defined within said flange body.

42. A rotary spindle assembly as claimed in claim 41 wherein said bore extends from an outer periphery of said flange body to an inner periphery of said flange body proximate a rotary spindle passage defined in said flange body.

43. (Cancelled)

44. A rotary spindle assembly comprising:

a rotary drive motor;

a rotary spindle rotatably responsive to said rotary drive motor;

a wafer support secured to said rotary spindle so as to be rotatable therewith;

a heat regulating flange positioned between said rotary drive motor and said wafer support; and

a heat regulating element positioned between said heat regulating flange and said wafer

support, said heat regulating element comprising:

a frame disposed about said rotary spindle; and

a fluid conduit coupled to said frame such that a heat regulation void is defined between said spindle and said fluid conduit, said heat regulation void thermally coupled to said fluid conduit such that upon passage of said fluid through said fluid conduit and upon passage of an exhaust gas through said heat regulation void, an exchange of heat occurs between said exhaust gas and said fluid.

45. A rotary spindle assembly as claimed in claim 44 wherein said fluid conduit is disposed within said frame to define a substantially cylindrical shape to said heat regulation void.

46. A rotary spindle assembly as claimed in claim 45 wherein said fluid conduit is disposed within said frame in a substantially circumferential path.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application of

Applicants : John T. Davlin et al.
Serial No. : 09/651,498
Filed : August 30, 2000
Title : TEMPERATURE CONTROL ELEMENTS, SPINDLE ASSEMBLY AND WAFER PROCESSING ASSEMBLY INCORPORATING SAME
Docket : MIO 0071 PA (00-0430)
Examiner : R. Kackar
Art Unit : 1763

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that this correspondence is being sent via facsimile to the Board of Appeals and Patent Interferences at (703) 308-7952 on August 11, 2004.

John T. Reed Reg. No. 46,506

Sir:

APPEAL BRIEF

This is an appeal from the Office Action mailed May 5, 2004, finally rejecting claims 36, 39-42 and 44-46. A Notice of Appeal was timely filed on June 11, 2004. A Credit Card Payment Form (PTC-2038) in the amount of $330.00 accompanies this Brief. 37 CFR §1.17(c).

(1) Real Party In Interest

The real party in interest is the Assignee of this patent application, Micron Technology, Inc., a corporation of the State of Idaho, by assignment from the named inventors, which assignment has been recorded at the United States Patent & Trademark Office on December 4, 2000, Reel 011345, Frame 0799.

(2) Related Appeals and Interferences

The Appellants have filed a Notice of Appeal dated August 9, 2004 on a related divisional application (serial number 10/320,073, filed December 16, 2002), also before the same Examiner.

(3) Status of Claims

Claims 36, 39-42 and 44 through 46 are present in this patent application, and all stand finally rejected. Claims 1 through 35, 37, 38 and 43 have been cancelled. Accordingly, claims 36, 39 through 42 and 44 through 46 are before this Board on appeal. A correct copy of the appealed claims appears as an Appendix to this Brief.

(4) Status of Amendments

All previous amendments have been entered. The Appellants have not filed any response or amendment subsequent to the Final Office Action.

(5) Summary of the Invention:

The Appellants' invention relates to a rotary spindle assembly for production of wafers (such as semiconductor wafers) wherein a wafer is coated or otherwise processed while supported on a rotatable wafer support. Specialized temperature control and spindle rotation features, as well as wafer processing equipment are provided to improve wafer processing uniformity and accuracy. The temperature control features, including a heat regulating element **50** and a heat regulating flange **30**, are arranged as part of the assembly. The heat regulating element is made up of a fluid conduit **58** that defines a substantially cylindrical heat regulation void about at least a portion of a rotary spindle **24**. In addition, the heat regulating element **50** and the attendant gas path defined therethrough is of an open framework construction such that a substantial degradation of the gas flow profile is avoided. During assembly operation, the configuration is such that a thermal control fluid (for example, water) passes through the fluid conduit **58** and exchanges heat with the gas that is being circulated through the heat regulation void and past a support **70** of a wafer **75** being processed. As shown in FIGS. 2 and 4 of the original specification, the flowpath traversed by fluid conduit **58** can be of a helical shape and sized by diameter **a** relative to the diameter **b** of spindle **24** such that the heat regulation void takes up the space between them. The heat regulating flange **30** (shown in original FIGS. 1 through 3) is disposed between the heat regulating element **50** and a controller **60**,

and serves to thermally decouple the wafer and its support from the rotary spindle, motor and related componentry.

(6) Issues

(a) Whether claim 36 is nonobvious under 35 USC §103(a) over U.S. Patent 5,762,709 to Sugimoto et al (hereinafter the '709 patent) in view of U.S. Patent 5,578,127 to Kimura (hereinafter the '127 patent).

(b) Whether claims 44 through 46 are nonobvious under 35 USC §103(a) over the '709 patent in view of the '127 patent.

(c) Whether claims 39 through 42 are nonobvious under 35 USC §103(a) over the '709 patent in view of the '127 patent and further in view of U.S. Patent 6,107,608 to Hayes (hereinafter the '608 patent).

(7) Grouping of Claims

The Applicant will argue each ground of rejection using representative claims. Claim 36 is representative of claim 36 in regard to the §103 rejection of unpatentability over the '709 patent in view of the '127 patent. Claim 44 is representative of claims 44 through 46 in regard to the §103 rejection of unpatentability over the '709 patent in view of the '127 patent. Claim 39 is representative of claims 39 through 42 in regard to the §103 rejection of unpatentability over the '709 patent in view of the '127 patent and further in view of the '608 patent. As such, the representative claims do not stand or fall together.

(8) Argument

(a) Claim 36, which recites an open framework heat regulating structure defining a heat exchange relationship between fluid in a fluid conduit and a gas passing through a substantially cylindrical heat regulating void that is at least partially formed by the fluid conduit, is nonobvious under 35 USC 103(a) over the '709 patent in view of the '127 patent.

The Examiner asserts that the combination of the '709 and '127 patents show a wafer coating apparatus with the claimed heat regulating element; however, recourse to these references is unavailing, as there in neither a teaching nor a suggestion of the claimed open framework heat regulating element. Accordingly, the Examiner's position is deficient as a matter of law, as it fails to satisfy all of the requirements of a proper obviousness rejection. "To establish a *prima facie* case of obviousness, three basic criteria must be met." MPEP 2142. Among these is the bedrock principle that all claim limitations should be taught or suggested. MPEP 2143.03. In the present case, there are at least two examples of the Examiner ignoring this stricture. First, the airflow mechanism of the '709 patent used in a heat regulating capacity teaches a closed configuration, as evidenced by the air supply conduit **30** and damper **40** shown in FIG. 2 in conjunction with frequent description of the small nature of the conduit openings discussed at column 5, lines 39 through 43. The Appellants position has been all along that the preservation of gaseous flow characteristics through an open framework enhances the performance of the assembly. The entrained, damper-based approach adopted by the '709 patent is not only not taught or suggested, but represents a complete dissimilarity in the way thermal management issues are addressed. This distinction is not remedied by the '127 patent, where its complete absence of any type of framework, whether open or closed, about a spindle such that a heat regulation void is defined between the spindle and element prevents the Examiner's use of the '127 patent as a secondary teaching. The Examiner's position, that the fluid temperature control of the flange of the '127 patent teaches a heat exchange device similar to that of

the claimed device, is misplaced, as it seeks to mimic the open framework heat regulation void defined between the spindle and fluid conduit where no such structure exists.

Second, while the combination of the '709 and '127 patents does teach a wafer coating device with an adjustable airflow mechanism to circulate air around a rotary spindle, it is silent as to using a heat exchange arrangement between the flowing air and a heat regulating fluid disposed in conduit around that spindle. Furthermore, neither of the teachings of the '709 or '127 patents, taken alone or together, even remotely suggest the possibility of having the aforementioned heat exchange relationship between the two fluids, nor could they expect to, as the '709 patent is silent as to using a heat exchange fluid, and the '127 patent limits the use of such fluid to the heat regulating flange, avoiding any discussion as to any applicability of a heat exchange relationship between the exhaust gas and a cooling fluid in the vicinity of the spindle. The Examiner candidly admits in numbered paragraph 2 of the May 5, 2004 Office Action that the '709 patent does not teach the construction of the claimed heat regulating element, and attempts to rectify this deficiency by recourse to the '127 patent. Whatever features the '127 patent discusses, a heat-exchange fluid conduit disposed about the rotary spindle is not one of them. As an attempt to gloss over this shortcoming of the secondary reference, the Examiner asserts at the bottom of page 4 of the February 10, 2004 Office Action that heat exchange occurs with fluid in a conduit "all around", leaving the meaning of such phrase open to speculation. There is no evidence that the '127 patent teaches or suggests that a fluid conduit be placed about the spindle **31a** to effect a heat exchange relationship with exhaust gas flowing past the spindle. In fact, the only discussion in the '127 patent of conduit used to transport heat exchange fluid is made in conjunction with the aforementioned flange **31b** (described at column 5, lines 17 through 29) and plate **20** (described at column 4, lines 47 through 51), as well as the resist supply nozzle **30** (described at column 5, lines 30 through 41). None of the heat exchange configurations depicted in the '127 patent contemplate a fluid conduit in heat exchange relationship with an exhaust gas in the region about the spindle for the purpose of cooling the exhaust gas. As such, the device of the '127 patent does not augment the teaching of the admittedly deficient '709 patent.

In addition to not teaching or suggesting every element of the claimed invention, the combination of the '709 and '127 patents is found wanting for other reasons. In particular, another portion of the tripartite test for a *prima facie* case of obviousness requires that there must be some motivation to combine the references. MPEP 2143.01. The antithesis of such motivation occurs when the reference(s) teach away from each other or the claimed invention; such a teaching away is a *per se* demonstration of lack of *prima facie* obviousness. See, e.g., *In re Dow Chemical Co.*, 837 F.2d 469, 5 USPQ2d 1529 (Fed. Cir. 1988). In the present case, the relatively closed configuration of the '709 patent not only does not avoid disruption of the exhaust gas flow within the assembly, but actually promotes it by increasing, decreasing or cutting off the air supply as needed. Using FIG. 2 relied on by the Examiner, it can be seen that the '709 patent teaches a substantially closed air supply conduit **30** arranged about the spindle **1a**. The air supply conduit **30** of the '709 patent is expressly presented to control the supply of air through the conduit to the lower surface of the substrate by using an air flow adjusting unit **50** coupled with a damper **40**. It will be appreciated by those skilled in the art that such a damper-based arrangement by its very nature defines a closed framework, and as such alters the exhaust gas profile defined by the wafer processing bowl. This stands in stark contrast to the open framework architecture of the claimed device, where (as stated at pages 3 and 11 of the original specification) the dimensions of the gas flow path avoid substantial degradation of a wafer processing assembly gas flow profile.

For this additional reason, continued reliance on the '709 patent as a primary reference is misplaced, as MPEP 2141.02 clearly recognizes that the "reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention." Thus, even assuming *arguendo* that there are features common to both the '709 patent and the claimed device, the presence of the closed air conduit and accompanying damper of the former provides indicia that the totality of the two devices are significantly different. With regard to independent claim 36, both the relatively closed framework of the '709 patent and the flow-disrupting damper mechanism are inconsistent with the stated purpose discussed above for the claimed device. Thus, Examiner's use of

the '709 patent presents a classic example of teaching away that is insufficient to render the claims at issue obvious.

(b) Claims 44 through 46, which recite structure defining a heat exchange relationship between fluid in a fluid conduit and a gas passing through a substantially cylindrical heat regulating void that is at least partially formed by the fluid conduit, are nonobvious under 35 USC 103(a) over the '709 patent in view of the '127 patent.

The Appellants' position regarding the inapplicability of the '709 and '127 patents, both individually and collectively, to the fluid conduit configuration of the heat regulating element of claim 36 discussed above is also relevant to claims 44 through 46, and for that reason alone is sufficient to overcome the Examiner's rejection. In addition, particular recitations within claim 44 that are not shared with claim 36 make the former separately patentable. For example, the heat regulating element of claim 44 additionally recites a frame to which the fluid conduit is coupled. The Examiner was keenly aware of this feature and its absence from the '709 patent, stating on page 2 of the May 5, 2004 Office Action that the '709 patent does "not disclose the regulating frame with fluid inlet and outlet". Yet, despite this clear admission, the Examiner then proceeds to ignore the frame limitation in the remainder of the rejection, as nowhere else is mention made of this shortcoming in the '709 patent or how the '127 patent corrects such shortcoming. "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970)). Based on the combined failure of the Examiner to address this limitation and the lack of such limitation in the teaching of the '127 patent, the Appellants submit that these words were not considered in judging claim patentability. In light of this, for the Examiner to baldly hold that either of the '709 or '127 patents include such a frame as part of the heat regulating element would be to destroy the plain meaning of that claim requirement, and as such is contrary to present United States Patent and Trademark Office practice.

In addition, claim 44 specifically recites the heat regulating flange being disposed between the rotary drive motor and the wafer support, with the heat regulating element (frame included) positioned between the flange and wafer support. While the '127 patent includes a flange **31a** disposed between the rotary drive motor **31** and the wafer support **28** (as shown in FIG. 2), there is no evidence of a frame-based heat regulating element positioned between them and about the spindle such that a fluid can be routed through conduit that is coupled to the frame. Thus, as neither the '709 nor '127 patents teach or even remotely suggest the claimed arrangement of the heat regulating flange relative to the heat regulating element, as well as their relationship to the claimed rotary spindle assembly, the present rejection is defective, and must be withdrawn.

(c) Claims 39 through 42 that recite structure defining a heat exchange relationship between fluid in a fluid conduit and a gas passing through a substantially cylindrical heat regulating void that is at least partially formed by the fluid conduit, and that include a temperature-responsive heat regulating flange are nonobvious under 35 USC 103(a) over the '709 patent in view of the '127 patent and further in view of the '608 patent.

In the final rejection, the Examiner rejected claims 39 through 42 under 35 USC §103 as unpatentable over the '709 patent in view of the '127 patent and further in view of the '608 patent. The Appellants' position regarding the inapplicability of the '709 and '127 patents, both individually and collectively, to claims 36 and 44 through 46 discussed above is also relevant to claims 39 through 42, and for that reason alone is sufficient to overcome the Examiner's rejection. Moreover, the additional recitation of particular features relating to the heat regulating flange provides additional bases for distinguishing over the cited references. In the claimed device, the flange is one of a plurality of heat control devices in the assembly to provide thermal control of the gaseous environmental within the assembly, while the temperature-sensor embedded chuck of the '608 patent acts as a direct conductive temperature control of the wafer being processed. Claim 39 recites that

the heat regulating flange of claim 36 further comprises a temperature sensor positioned within the flange body. By contrast, the device taught in the '608 patent is a wafer chuck **20** upon which is placed the wafer **17** to be processed such that "active controlling of the temperature of the support surface" is achieved, as discussed at column 3, lines 12 through 13. Moreover, column 6, lines 14 through 19 state that "the chuck **20** is preferably maintained near or at the desired temperature for the wafer", and that the placement of the chuck **20** and wafer **17** is to ensure thermal equilibrium between the two. Thus, while the chuck may have a temperature sensor positioned within it, it is clear that the chuck is not the same as the claimed heat regulating flange, as the chuck **20** of the '608 patent is a conductive heat transfer device operating specifically on and in contact with the wafer **17**, while the flange of the claimed device insulates the gaseous environment within the assembly from the heat generated by the motor used to rotate the spindle. Furthermore, the difference in placement of the claimed flange versus the chuck **20** of the '608 patent belies any similarity in function, as the flange is disposed at the "lower spindle area" according to claim 36 while the chuck **20** of the '608 patent must, out of necessity, be in physical contact with the wafer **17**. This dissimilarity is further evidenced by the position taken by the patentee in the '608 patent, where at column 8, lines 46 through 51, the active control of chuck **20** is used to directly control the temperature of wafer **17** thereby reducing or eliminating the need for the environmental control system of the claimed invention.

Conclusion

For all of these reasons, Appellants submit that the rejections are not well taken, and all rejections of the claims should be reversed in their entirety by this Board.

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APPENDIX

CLAIMS ON APPEAL

1-35 (Cancelled)

36. A rotary spindle assembly comprising a rotary drive motor, a rotary spindle, a wafer support, a wafer processing bowl, a heat regulating flange, and a heat regulating element, wherein:

said wafer support is secured to said rotary spindle so as to be rotatable with said spindle;

said rotary spindle defines a lower spindle area and an upper spindle area;

said rotary spindle is mechanically coupled to said rotary drive motor in said lower spindle area;

said heat regulating flange is positioned in said lower spindle area;

said heat regulating element is positioned in said upper spindle area between said heat regulating flange and said wafer support such that a fluid conduit disposed in said heat regulating element and configured to transport a thermal control fluid therethrough defines a substantially cylindrical heat regulation void about a portion of said rotary spindle in said upper spindle area, said heat regulation void thermally coupled to said fluid conduit such that upon passage of a fluid through said fluid conduit and exhaust gases through said heat regulation void, an exchange of heat occurs therebetween; and

said heat regulating element defines an open framework arranged about said rotary spindle such that upper and lower ends of said heat regulating element are open to said substantially cylindrical heat regulation void from said lower spindle area to said upper spindle area.

37. (Cancelled)

38. (Cancelled)

39. A rotary spindle assembly as claimed in claim 36 wherein said heat regulating flange further comprises a temperature sensor positioned within said flange body proximate said rotary spindle passage.

40. A rotary spindle assembly as claimed in claim 39 wherein said rotary spindle assembly further comprises:

at least one liquid source coupled to said fluid conduit; and

a controller coupled to said at least one liquid source and said temperature sensor, said controller being programmed to be responsive to a temperature signal generated by said temperature sensor.

41. A rotary spindle assembly as claimed in claim 39 wherein said temperature sensor is positioned within a bore defined within said flange body;

42. A rotary spindle assembly as claimed in claim 41 wherein said bore extends from an outer periphery of said flange body to an inner periphery of said flange body proximate a rotary spindle passage defined in said flange body.

43. (Cancelled)

44. A rotary spindle assembly comprising:

a rotary drive motor;

a rotary spindle rotatably responsive to said rotary drive motor;

a wafer support secured to said rotary spindle so as to be rotatable therewith;

a heat regulating flange positioned between said rotary drive motor and said wafer support; and

a heat regulating element positioned between said heat regulating flange and said wafer

support, said heat regulating element comprising:

a frame disposed about said rotary spindle; and

a fluid conduit coupled to said frame such that a heat regulation void is defined between said spindle and said fluid conduit, said heat regulation void thermally coupled to said fluid conduit such that upon passage of said fluid through said fluid conduit and upon passage of an exhaust gas through said heat regulation void, an exchange of heat occurs between said exhaust gas and said fluid.

45. A rotary spindle assembly as claimed in claim 44 wherein said fluid conduit is disposed within said frame to define a substantially cylindrical shape to said heat regulation void.

46. A rotary spindle assembly as claimed in claim 45 wherein said fluid conduit is disposed within said frame in a substantially circumferential path.